

WHAT IS CLAIMED IS:

1. A method of treating a wafer thermally to remove defects contained in single crystalline semiconductor, the method comprising the steps of:

carrying out a first heat treatment on the wafer at a temperature equal to or higher than 1200 °C; and

carrying out a second heat treatment on the wafer at a temperature equal to or lower than 800 °C.

10 2. The method of treating a wafer thermally according to claim 1, wherein the first heat treatment is carried out for a time period ranging from 20 minutes to 3 hours.

Sub B2 15 3. The method of treating a wafer thermally according to claim 1, wherein the first heat treatment is carried out at an ambience of one of hydrogen, inert gas, a first mixed gas of hydrogen and inert gas, and a second mixed gas of oxygen and inert gas.

4. The method of treating a wafer thermally according to claim 3, wherein flow of the inert gas, the first mixed gas, and the second mixed gas ranges from 2 to 50 slm.

20 5. The method of treating a wafer thermally according to claim 1, wherein a rate of temperature increase in the first heat treatment is from 5 to 100 °C/min. and a rate of cooling after the first heat treatment is from 5 to 100 °C/min.

6. The method of treating a wafer thermally according to claim 1, wherein the second heat treatment is carried out for 2 minutes or less.

7. The method of treating a wafer thermally according to one of claim 1, wherein the wafer is made of silicon.

8. A method of producing a semiconductor wafer, comprising the steps of:  
producing a single crystalline semiconductor ingot by removing an OiSF ring by means of moving the OiSF ring from a center of a single crystalline semiconductor growth axis to a circumference and by extending a first area and a second area in which delta (Oi) as oxygen concentration difference between initial oxygen concentration and oxygen concentration after heat treatment in N<sub>2</sub> ambience at 1000°C for 64 hours, is more greatly increased than other areas;

providing a wafer by slicing the single crystalline semiconductor ingot;  
carrying out a first heat treatment on the wafer at a temperature equal to or higher than 1200°C; and

carrying out a second heat treatment on the wafer by rapid thermal annealing at a temperature equal to or lower than 800°C.

9. A semiconductor wafer which is fabricated from a single crystalline semiconductor,

wherein the wafer is produced from a single crystalline semiconductor ingot which is formed by removing an OiSF ring by means of moving the OiSF ring from a center of a single crystalline semiconductor growth axis to a circumference and by extending a first

area and a second area in which  $\Delta(O_i)$ , as oxygen concentration difference between initial oxygen concentration and oxygen concentration after heat treatment in  $N_2$  ambience at  $1000^\circ\text{C}$  for 64 hours, is more greatly increased than other areas, wherein grown-in defects are removed from the wafer by heat treatment, wherein bulk micro-defects are formed in the wafer, and wherein a defect-free layer is formed from a surface of the wafer to a predetermined depth.

10. The semiconductor wafer according to claim 9, wherein the first area and the second area in which  $\Delta(O_i)$  is greatly increased is extended to 20 to 90% of a wafer diameter.

11. The semiconductor wafer according to claim 9, wherein the defect-free layer is formed to a thickness of 10 to  $100\mu\text{m}$  from the surface.

12. The semiconductor wafer according to claim 9, wherein a first heat treatment is carried out on the wafer at a temperature equal to or higher than  $1200^\circ\text{C}$  and subsequently a second heat treatment is carried out on the wafer by rapid thermal annealing at a temperature equal to or lower than  $800^\circ\text{C}$ .

13. The semiconductor wafer according to claim 9, wherein the semiconductor wafer is a silicon wafer.

14. An epitaxial semiconductor wafer,  
wherein the wafer is produced from a single crystalline semiconductor ingot which

is formed by removing an OISF ring by means of moving the OISF ring from a center of a single crystalline semiconductor growth axis to a circumference and by extending a first area and a second area in which  $\Delta(O_i)$  as oxygen concentration difference between initial oxygen concentration and oxygen concentration after heat treatment in  $N_2$  5  
ambience at  $1000^\circ C$  for 64 hours, is more greatly increased than other areas, wherein grown-in defects are removed from the wafer by heat treatment, wherein bulk micro-defects are formed in the wafer, wherein a defect-free layer is formed from a surface of the wafer to a predetermined depth, and wherein an epitaxial layer is formed on an upper surface of the wafer.

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15. The epitaxial semiconductor wafer according to claim 14, wherein the epitaxial layer is formed 1 to 20  $\mu m$  thick.

16. The epitaxial semiconductor wafer according to claim 14, wherein a first heat 15  
treatment is carried out on the epitaxial semiconductor wafer for 20 minutes to 3 hours and a second heat treatment is carried out on the wafer by rapid thermal annealing for a time equal to or less than 2 minutes.

17. A method of growing an ingot, comprising the steps of:

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accelerating a speed of growing from a melt-down silicon to a single crystalline silicon ingot;

maintaining a temperature gradient distribution from a central part to a circumferential part of the ingot at a growing interface between the melt-down silicon and the ingot grown by crystallization;

forming an OiSF ring at the circumferential part by moving the OiSF ring from a center of a single crystalline semiconductor growth axis to a circumference; and

extending an area in which delta (Oi) is greatly increased as compared to that of other areas, wherein the delta (Oi) is a difference between an initial oxygen concentration and oxygen concentration after heat treatment with a predetermined thermal history.

18. The method of growing an ingot according to claim 17, wherein the heat treatment with the predetermined thermal history is carried out at 1000°C for 64 hours in a N<sub>2</sub> ambience.

19. The method of growing an ingot according to claim 17, wherein the area in which delta (Oi) is greatly increased is formed to occupy 20 to 90% of a diameter of the ingot.